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ABSTRACT

Iowa State University, through a program called Project BIO, is using an innovative new approach to offer biology courses via the World Wide Web. The approach features online lectures similar to those a student might experience in a traditional classroom. Students listen to the lectures using RealAudio while viewing lecture materials with a Web browser. The program, which began in Fall 1996 with two courses, has grown to eight courses for the 1997/98 academic year. The market for these courses includes on-campus Iowa State University students, high school juniors and seniors, community college students, high school and community college biology teachers, and employees of life science companies. Topics discussed in this paper include: course approach and technology; course descriptions and target audiences; student access; authentic learning experiences; course administration; and course development, including the Project BIO Resource Center (designed to assist faculty in the development of online courses by providing technology resources, technical assistance, and training), Web page authoring, and audio technology. Figures illustrate a typical lecture window, the RealPlayer control panel, plans for the Project BIO Resource Center. Two tables present enrollment for 1996/97 courses and target audiences for 1997/98 courses. (Author/AEF)

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Teaching Biology on the Internet

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Abstract: Iowa State University, through a program called Project BIO, is using an innovative new approach to offer biology courses via the World Wide Web. The approach features on-line lectures similar to those a student might experience in a traditional classroom. Students listen to the lectures using RealAudio® while viewing lecture materials with a Web browser. The program, which began in Fall 1996 with two courses, has grown to eight courses for the 1997/98 academic year. The market for these courses includes: on-campus Iowa State University students, high school juniors and seniors, community college students, high school and community college biology teachers, and employees of life science companies.

Introduction

The internet is an exciting new medium for teaching biology at a distance. On-line biology courses offer a flexible learning environment where course materials can be accessed any time, day or night, from any location where a suitable computer connected to the internet is available. These courses support multiple learning styles (written, verbal and visual) and their content can be customized to meet the individual interests/needs of students. Another key feature of these courses is the ability to access authentic research databases as well as educational resources from other colleges and universities.

Iowa State University, through a program called Project BIO, is pioneering an innovative new approach for delivering courses and other educational material via the World Wide Web [1]. Iowa State is also exerting national leadership in the number and variety of biology courses that we are making available through this medium. Project BIO is a partnership involving educators in 7 departments and programs at Iowa State University, 14 of 16 Iowa community colleges and 43 Iowa high schools. The purpose of the partnership is to develop and share biology education resources via the internet. For more information see the Project BIO World Wide Web site (http://project.bio.iastate.edu).

Approach and Technology

Our approach features on-line lectures that are similar to presentations made in a traditional on-campus classroom. These presentations, which are available 24 hrs/day via the internet, consist of a set of slides that are accessed as Web pages and an audio explanation of the material on the slides. The audio portion of the presentation is being delivered using a new audio streaming technology called RealAudio®. Our approach represents a significant advance over the typical internet approach of delivering educational information using text and static images.

[1] Funding for this project was provided by grants from the Kellogg Foundation Vision 2020 project and the Howard Hughes Medical Institute. The following Iowa State University administrative units also provided support for this project: Provost , College of Agriculture , College of Liberal Arts and Sciences , Botany Department , Office of Biotechnology , Zoology & Genetics Department.

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Fig. 1 (Top Panel) shows a typical lecture window consisting of a menu frame and a frame for displaying slides. Slides can be accessed sequentially or randomly using the menu. The RealPlayer® functions as a helper application that is linked to the World Wide Web browser. [Fig. 1] (Bottom Panel) shows the RealPlayer® control panel. The audio portion of the lecture is accessed by clicking on an audio button which is present on each slide.

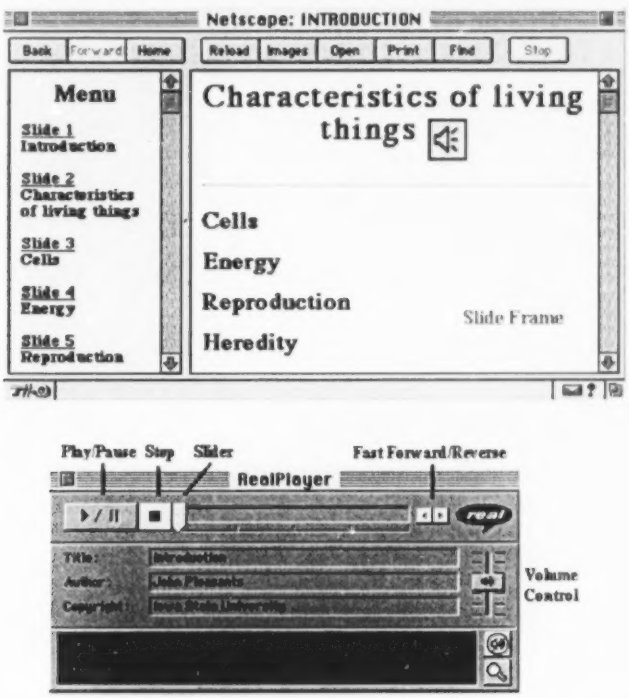

Figure 1: Typical lecture window (top) and RealPlayer® (bottom)

Courses and Audience

Iowa State University began offering on-line biology courses during Fall semester 1996 with two courses, "Biotechnology in Agriculture, Food and Human Health" and "Introduction to Basic Microbiology" [Tab. 1). These were the first two courses from ISU to be taught exclusively via the World Wide Web. During Spring semester 1997 four courses were offered with a total enrollment of 145 students. This represented a 5-fold increase over the Fall 1996 enrollment. About 60% of the students are off campus students and 40% are on campus. We expect to offer 8 on-line biology courses during the1997/98 academic year [Tab. 2]. Most of the courses have been adapted from existing on-campus courses and involve faculty who also regularly teach the courses to on-campus students in a traditional classroom setting. All of these courses are accessed from the Project BIO World Wide Web site (http://project.bio.iastate.edu). Byway of comparison CASO's: The Internet University (http://www.caso.com/), an authoritative guide to on-line courses, lists only four other universities that offer a total of five on-line biology courses.

Target audiences for our on-line biology classes include: on-campus Iowa State University students, high school juniors and seniors, community college students, high school and community college biology teachers, and employees of life science companies [Tab. 2].

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Semester	Course Number	Course Title	On Campus	Off Campus	Total
Fall 96	MIPM 302	Introduction to Basic Microbiology	7	3	10
	Gen 308/508	Biotechnology in Agriculture, Food and Human Health	2	17	19
		Totals	**9**	**20**	**29**
Spring 97	Biol 109	Introductory Biology, Non-majors	7	29	36
	Biol 201	Principles of Biology, Majors	6	37	43
	MIPM 302	Introduction to Basic Microbiology	36	7	43
	Gen 308/508	Biotechnology in Agriculture, Food and Human Health	11	12	23
		Totals	**60**	**85**	**145**

Table 1: Project BIO On-line Biology Courses, Fall 96 and Spring 97 Enrollments

Course Number	Course Title	Target Audience
Biol 109	Introductory Biology, Non-majors	ISU students, high school students
Biol 201	Principles of Biology, 1st Semester, Majors	ISU students, high school students
Biol 202	Principles of Biology, 2nd Semester, Majors	ISU students, high school students
MIPM 201	General Microbiology, Non-majors	ISU students, high school students
Zool 155	Basic Human Physiology and Anatomy, Non-majors	ISU students, high school students
MIPM 302	Introduction to Basic Microbiology	ISU students, community college students, industry employees
Gen 308/508	Biotechnology in Agriculture, Food and Human Health	ISU students, biology teachers, community college students, industry employees
MIPM 501X	Advanced Microbiology	ISU students, biology teachers, industry

Table 2: Project BIO On-line Biology Courses, Academic Year 1997/98

High School Students

Iowa's Post-secondary Enrollment Options Act [1] allows 11th and 12th grade students to enroll part time at an eligible community college, state university, or private college or university. The student's high school or school district pays for the cost of tuition, textbooks, materials and fees up to $250. Students earn both high school and college credits for the courses taken. This program provides opportunities for high school juniors and seniors to get a head start on college. It also makes challenging courses available for talented and gifted students. This program is especially important for small rural school districts in Iowa that often do not have the resources to offer Advanced Placement (AP) courses. For example, only 123 of ~400 high schools in Iowa offer an advanced placement biology course [2]. Moreover, to our knowledge there are no high schools in Iowa that offer college level biology courses for students heading for non-science majors.

[1] Excerpts from Iowa Post-secondary Enrollment Options Act (Chapter 261C) (http://project.bio.iastate.edu/Courses/pseoacod.htm)

[2] Educational Testing Service, personal communication.

Students who wish to exercise the Post-secondary Enrollment Option face two key problems in taking these courses. One is distance from the community college or university offering the courses. This issue is particularly important in Iowa where a significant proportion of the population lives in rural communities. A second important issue is scheduling. College classes are generally longer than high school classes, there is often significant travel time to a site where college classes are offered, and it is often difficult for high school students to schedule college classes around extracurricular activities.

Our on-line biology courses offer an ideal solution to many of these problems. Students can listen to on-line lectures at home or at their school at a time that is convenient to them. They can listen to an on-line lecture over two or more class periods.

Biology Teachers

In order to maintain their teacher certification high school biology teachers in Iowa need to take 6 college credits every 5 years and community college biology teachers need to take 4 credits during this same time period. Typically teachers must take courses or workshops in evenings or during the summer to fulfill these certification requirements. Evening courses are difficult to fit into a busy schedule while taking courses in the summer means loss of income. In addition the choice of courses in the evenings or during the summer semester is very limited. On-line courses offer an attractive alternative because teachers can work on these courses during the evenings or weekends at a time that is convenient for them.

On-Campus Students

About 40% of the students enrolled in our on-line biology classes are on-campus ISU students. Lower division biology courses are particularly attractive because of the very large class size (200-500 students) of traditional on-campus sections of these courses. They are typically heavily subscribed or over-subscribed making it difficult for students to fit the courses into their schedules. By way of contrast, students can access on-line lectures from their dorm rooms or from computer labs (on-campus or in the dorms) at anytime, 24 hours a day. The on-line biology courses are smaller and offer a more intimate learning environment with greater access to the instructor through the use of technologies such as e-mail, interactive Web pages and chat.

Student Access

Technology

Students need a computer (PC or a Mac) that is connected to the Internet at a minimum speed of at least 14.4 kbps. Two pieces of client software are required to access the lectures. A World Wide Web browser with frames capability for accessing the slides and the Real Player® for accessing the audio component of the lectures. Both software items can be downloaded from the internet [1] and are available at no charge to students.

On-Campus Students

They can access the courses using their own computer in their home, apartment or dormitory room. They can also use one of many computer labs located in their dormitories or on the campus. All dormitory rooms have ethernet ports providing students with fast access to the internet.

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[1] Two of the most popular browsers are Netscape Navigator (http://home.netscape.com/) and Microsoft's Internet Explorer (http://www.microsoft.com/). The RealPlayer® can be downloaded from (http://www.real.com/).

Off-Campus Students

Some of these students are able to access the course using a computer at home or work with access to the internet. However a major problem here is that more than 3/4 of the potential audience for internet courses does not have internet access [1]. A major factor is cost of the technology and this clearly discriminates against economically disadvantaged students. We are attempting to deal with this problem by working with Iowa high schools and community colleges to help them set up public access terminals that their students and faculty can use to access our on-line biology courses. To date these terminals have been established in 43 high schools and on five community college campuses.

Authentic Learning Experiences

An exciting educational feature of the internet is that it is possible for students to access and utilize information in authentic research databases as part of lectures or learning activities. In the "Biotechnology in Agriculture, Food and Human Health" course we have exploited this possibility in several learning activities that have been developed for the course. For example in an assignment called "Genetic Diseases", students are required to write a report about a genetic disease of their choice based on information obtained from the On-line Mendelian Inheritance in Man (OMIM) database (http://www3.ncbi.nlm.nih.gov/omim/).

Four of the learning activities in the biotechnology course are on-line lab simulations. In one activity called "Cloning by Computer", students access DNA sequences in the GenBank database (http://www.ncbi.nlm.nih.gov/) and then use a word processing program to cut and paste the DNA sequences together. This simulates a key step in the genetic engineering process. Two other activities involve taking the students through photographs of a wet laboratory demonstration and then having the students interpret data obtained in the lab. The third, called the Virtual FlyLab is a full-featured lab simulation developed at California State University, Los Angeles. In this simulation, students are able to design and interpret the results of virtual fly matings conducted on-line. The URL for the Virtual FlyLab is http://vflylab.calstatela.edu/edesktop/VirtApps/VflyLab/IntroVflyLab.html.

All of the learning activities developed for the biotechnology course are in the public domain and can be accessed from the biotechnology course homepage (http://project.bio.iastate.edu/courses/gen308/Home/Homepage1SS.html).

Course Administration

This is handled by software called ClassNet (http://classnet.cc.iastate.edu/) that was developed at Iowa State University. This software allows for on-line testing through an interactive page that can be accessed via a Web browser. Tests can include multiple choice, fill-in-the-blank and essay questions. The multiple-choice and fill-in-the-blank questions are machine graded whereas the instructor manually grades the essay questions. Students are required to identify a proctor in their local community who verifies the identity of the student and supervises the test. The proctor must supply a password before a student can access a test.

Classnet also provides several mechanisms for student/student and student/instructor interaction. These include the ability to send e-mail messages to students or instructors from the Web browser, a threaded class discussion forum in which messages can be sent using an interactive Web page and a chat feature that provides for real time communication.

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[1] CommerceNet/Nielsen Internet Demographics(http://www.commerce.net/work/pilot/nielsen_96)

Course Development

Project BIO Resource Center

The purpose of the center is to assist faculty in the development of on-line courses by providing technology resources, technical assistance and training. Technology in the center includes: 1) a World Wide Web server, 2) an 80 stream RealAudio/Video® server, 3) a sound-proof room with facilities for recording, digitizing and editing audio files, and 4) four general purpose World Wide Web authoring computers (3 Macintosh Power PC's and one Hewlett Packard VectraVL4). The facility also has a sound proof room which we will use to develop video content for the on-line courses. The room contains equipment for digitizing and editing video files and for recording voice-overs. Video content will be delivered using RealVideo® technology. The staff of the resource center includes the Professor-in-Charge, Tom Ingebritsen, a Technology Specialist, a Secretary, a Graduate Assistant and 3 Undergraduate Assistants. The staff maintains the technology, assists with the preparation and editing of course materials and provides training for faculty and staff. Plans for the Resource Center are shown in [Fig. 2]

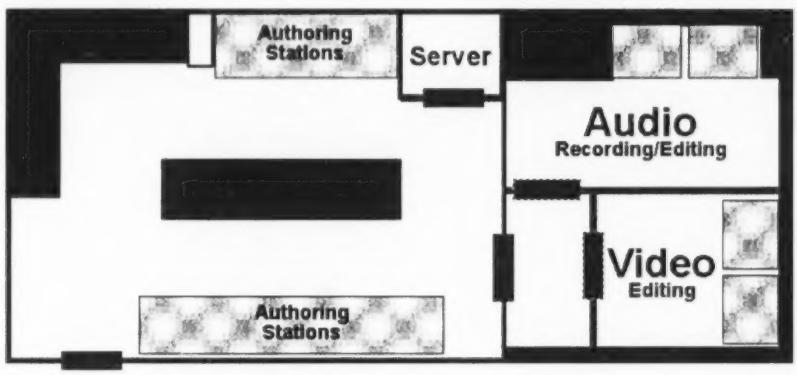

Figure 2: Plans for Project BIO Resource Center

Web pages

The majority of the Web authoring was done using a what-you-see-is what-you-get HTML authoring program called Claris Homepage (http://www.claris.com). In some cases the HTML editing capabilities of Netscape Navigator, Internet Explorer and Microsoft Office were also used.

Images and diagrams used in the lectures were created and/or edited using Adobe Photoshop (http://www.adobe.com) and Macromedia Freehand (http://www.macromedia.com). Some textbook images were used with appropriate attribution and permission from the publishers.

Audio

The audio part of the lectures were either directly recorded on a Macintosh Power PC computer (7500/100) computer or recorded using an analog tape recorder. In the latter case the contents of the analog tape were then input into the computer and digitized. SoundEdit 16 software was used to digitize and edit the audio files. The audio files were compressed and converted to the RealAudio format using RealAudio® Encoder software which is available from Progressive Networks (http://www.real.com) at no charge. Audio files were typically compressed from ~150 Mb for an uncompressed 1 hour lecture to 4-5 Mb in the RealAudio® format.

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